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**EVALUATION OF T RATIONS
AND THE MOBILE FOOD SERVICE
UNIT AT FORT LEWIS AND A
SUMMARY OF PRIOR FIELD TESTS**

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Combat Field Feeding	Military Equipment	Tray Packs												
Military Rations	Food Packaging	Mobile Food Service Unit												
Food Service	T Rations	MFSU												
Battlefields	Field Feeding	Fort Lewis												
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report presents a new concept in combat feeding systems designed to replace the present system which would be ill-suited to battlefield conditions anticipated in future conflicts. The two key elements of the proposed combat feeding concept are the Mobile Food Service Unit (MFSU) and the T rations. The results of testing at Ft. Lewis, WA and a summary of previous tests are presented. (Continued)														

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20. Abstract (Continued)

The following conclusions are drawn from these evaluations:
Tray-Pack items proved to be acceptable as field rations; the heating, delivering and serving of the T rations from the MFSU proved viable, and finally the MFSU can be efficiently operated by two personnel.

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PREFACE

This report is the third and last in a series of evaluations of the Mobile Food Service Unit and T rations conducted as part of the Department of Defense Food Research, Development, Testing and Engineering Program under the Joint Service Requirement, AMAF 81-20, Advanced Concepts for Combat Food Service; Appendix I, Evaluation of the Army Combat Field Feeding System.

The following individuals at the US Army Natick Research and Development Laboratories* made notable contributions to various phases of these evaluations. Mr. Cornelius McKeown of the Aero-Mechanical Engineering Laboratory (AMEL) was largely responsible for assembling the experimental prototype used in this and previous evaluations. Mr. Joseph MacKoul, also of AMEL, and Mr. Bruce Thomas of the Food Engineering Laboratory monitored the successful operations required to plan and to conduct this test.

Special recognition is accorded to Dr. Robert J. Byrne, Director, Operations Research and Systems Analysis Office* (1970 - 1981), for his special support and interest in the evaluation efforts during this field test. Since 1981, Dr. Byrne has been the Technical Director of US Army Natick Research and Development Center. Acknowledgement is likewise made to Dr. D. Paul Leitch for his special efforts in support of this project. Appreciation is also extended to Mrs. Diane Sears, Mrs. Cheryl Stoops, and Mrs. MaryEllen Jennings who have provided excellent secretarial assistance to this project.

Above all, recognition is given to Major David Mallory, who was Chief, Combat Service Support Branch, High Technology Test Bed during this test. Through his efforts the test was conducted with members of the 77th Armor Battalion, 2nd Brigade, 9th Infantry Division. CWO2 Randy Garvin, Brigade Food Advisor, and MSG Donald Talbot, Brigade Food Service Supervisor, provided valuable support throughout this operation. Without the cooperation and support of this group the evaluation would not have been possible.

*During the preparation of this report, the name of the installation was changed to US Army Natick Research and Development Center and the name of the preparing office was changed from Operations Research and Systems Analysis Office to the Directorate for Systems Analysis and Concept Development.

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EVALUATION OF T RATIONS AND THE MOBILE FOOD SERVICE UNIT
AT FORT LEWIS AND A SUMMARY OF PRIOR FIELD TESTS

I. BACKGROUND

Original Concept

In anticipation of changing battlefield needs during the 1990's and beyond, more responsive methods for feeding Army troops in the field become necessary. The US Army Natick Research and Development Laboratories (NLABS), recently renamed US Army Natick Research and Development Center, has outlined a new concept for field feeding in two technical reports, NATICK/TR-78/025¹ and NATICK/TR-80/027.² The new concept provides for feeding at all levels of commitment, under different combat conditions, and has provisions for medical, individual, and squad foodservice requirements.

This new field feeding concept seeks to fulfill the requirements of the highly mobile and widely dispersed battlefield of the 1990's and beyond. Since the existing system remains essentially unchanged from its pre-World War II origins, the new system incorporates many recent advances in food and packaging technology. Still, the objective of the new system is to provide the troops with at least one hot meal per day throughout the theater, whenever possible. To achieve this objective, the new system must be highly mobile, capable of heating rations on the move, and highly responsive.

This report covers the unique components of the new system: Tray Packs and the Mobile Food Service Unit (MFSU). A series of three evaluations have been conducted to determine if serving Tray-Pack foods to troops in simulated combat conditions using the MFSU is a viable concept. The purpose of this report is to present the results obtained from the third and final evaluation of the series, conducted at Fort Lewis, Washington.

Two similar evaluations were conducted at Fort Bragg, North Carolina and Fort Devens, Massachusetts. Selected information from these exercises is included for comparison so that a more complete statement on the viability of the Army Combat Food Service System for the 1990's can be made. Detailed information on these two evaluations can be obtained from the individual reports, NATICK/TR-82/043³ and NATICK/TR-83/012.⁴

¹R. J. Byrne, A proposed system for Army combat forces in the 1990's. NATICK/TR-78/025, May 1978. (AD A055091)

²R. J. Byrne, S. Baritz, R. Decareau, G. Hertweck, H. Kirejczyk, I. Nii, A proposed combat food service system concept for the Army in 1990. NATICK/TR-80/027, January 1980. (AD A113311)

³J. Wall, D. P. Leitch with E. Comstock, Evaluation of T-rations and the Mobile Food Service Unit in a field exercise: Fort Devens. NATICK/TR-82/043, September 1982. (AD A124859)

⁴J. Wall, D. P. Leitch, Evaluation of T-rations and the Mobile Food Service Unit in a field exercise: Fort Bragg. NATICK/TR-83/012, April 1982. (AD A127768)

The Mobile Food Service Unit

The MFSU is an assembly of components capable of operating on the ground or on a truck, trailer, or similar combat vehicle. The purpose of the MFSU is to provide a capability to heat Tray Packs on the move and to serve them to troops in forward areas. The MFSU is used to bring hot food to the troops rather than require them to go to a kitchen area or otherwise subsist on an individual ration that may be less acceptable.

The Letter of Agreement (LOA)⁵ required that an MFSU be developed as a component of the system and that the following features be incorporated:

- ° The unit must be able to heat T rations packaged in a container approximately 10" x 12" x 3" from 250°F to 170°F in less than 30 minutes.
- ° It must be large enough so that sufficient rations may be heated to feed up to 120 people at one time.
- ° The equipment is to be skid-mounted and suitable for use on a 2½-ton truck bed or its replacement vehicle, on a 1½-ton trailer, or on the ground.
- ° The unit is to be fully operational for meal service within ten minutes of arrival at the feeding site.
- ° The unit is to take no more than ten minutes to be fully prepared for movement to the next site.
- ° The unit is to have some means to protect the equipment and serving line from environmental conditions during transportation, food heating, and serving operations.
- ° The unit is to be capable of transporting and storing 120 gallons of potable water and able to dispense it to the customer through no less than four outlets.
- ° The equipment, when trailer mounted, must be capable of being sling-loaded for airlift by rotary winged aircraft.

Figure 1 is an illustration of the Mobile Food Service Unit as originally conceived. Although the prototype unit tested differs in certain details, the main components remain as indicated in the illustration.

⁵LOA for Combat Field Feeding System, US Army Training and Doctrine Command (USATRADOC), ACN 44499, February 1981.

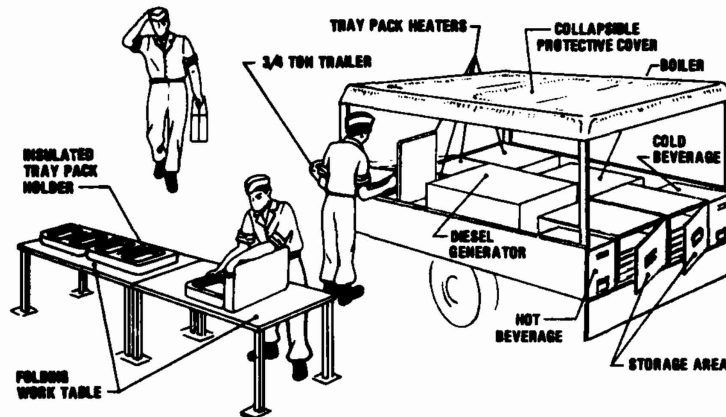


Figure 1. Original MFSU concept

The components of the NLABS experimental prototype MFSU tested include a generator, a boiler, the hot water tank (Tray-Pack converter), an insulated holding container, folding utility tables, a serving table, and a wooden container for holding and dispensing disposables. As required in the LOA, each component was portable and can be moved by two individuals. Since the unit was an experimental prototype, not all criteria in the LOA were met. For example, the NLABS prototype did not incorporate the requirement to hold 120 gallons of water. This requirement was excluded because of the proximity of trailers capable of supplying 400 gallons of water when needed. The elimination of this requirement significantly reduces the total weight of the MFSU. The evaluations were conducted to validate the MFSU concept and to develop hands-on experience that would provide the basis for determining the specific performance characteristics for the production model.

The T Ration

The T ration consists of fully prepared, thermostabilized entrees, vegetables, starches, and dessert items packaged in half-sized steamtable pans supplemented with such items as salad, bread, and beverages. The term "T ration" is derived from the primary meal component, the Tray Pack, which refers to the half-sized steamtable pans. The extensive use of the Tray Pack distinguishes the T ration from other rations served in the field -- the A ration, the B ration, and the Meal, Ready-to-Eat (MRE). Like the A and B rations, the T ration is a bulk ration. Since the Tray Pack is flat, prepared foods that were impractical in cylindrical cans can now be made available in a

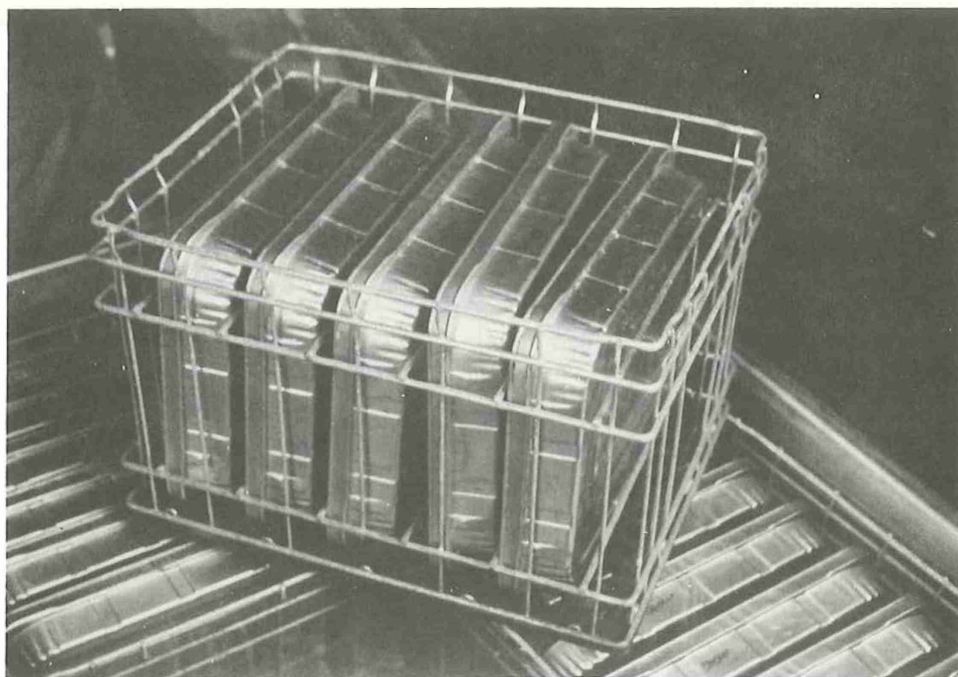


Figure 2. Tray Packs in holding container

shelf-stable commodity. Examples of such items are lasagna, stuffed peppers, stuffed cabbage, salisbury steak, chicken legs, and chicken breasts. Figure 2 shows Tray Packs in a milk case type container ready to be submerged for heating in a hot water bath.

The Tray Pack

The Tray Pack is a recent concept in food processing originating with a breakthrough in packaging technology; specifically, the formation of a smooth-wall, foil container of single-serving size that could be hermetically sealed and thermally processed. Subsequent investigation and development led to the introduction of a heavier duty, drawn container holding 12 to 24 servings in a half-sized steamtable tray. The Tray Pack has about the capacity of a No. 10 can or 105 fluid ounces, and is designed to fit into a 12" x 20" steamtable top opening.

The Tray Pack is fabricated from precoated sheet steel by the drawn/redrawn method in one piece with a step shoulder on the wall to support it in the steamtable top opening. The tray lids are designed for double seaming with conventional can closing machinery to form a positive hermetic seal. This double seam allows standard can opening devices to be used with the Tray Packs. The flat shape of the container reduces thermal processing times, and studies show that food processed in Tray-Pack containers requires less than 50% of the processing time for the same product packed in a No. 10 can. This translates into a savings of time and energy and also results in better food quality.

II. CONCEPT EVALUATION

The specific objectives of the Fort Lewis exercise were as follows:

1. To demonstrate the reliability of the MFSU in heating Tray Packs while on the move and delivering hot T rations to combat troops.
2. To demonstrate the acceptability of Tray-Pack products to troops in the field.
3. To demonstrate that two personnel can efficiently operate the MFSU.
4. To evaluate the acceptability of canned bread products.
5. To determine the effectiveness of modifications made to the MFSU prototype as a result of previous tests in an attempt to improve durability during shipping and handling.

The system evaluation conducted at Fort Lewis during January 1982 differed from previous exercises in two aspects. First, two hot Tray-Pack meals per day were served in the field to tank crews, armored personnel, and mounted infantry members of the 77th Armor Battalion, 9th Infantry Division. In earlier tests, only one hot Tray-Pack meal was served daily. Second, canned bread (Figure 3) was used in the field for the first time in conjunction with the T Ration and MFSU. Commercially prepared bread was served during the previous evaluations. The two hot meals were served from the MFSU at noon and in the evening, with the breakfast meal prepared in the dining hall and transported to the field in insulated containers. By including a second Tray-Pack meal, no field kitchen was required. The data collection plan, like those in previous evaluations, focused on foodservice labor requirements, customer acceptance of the foods served, and the operation of the MFSU.



Figure 3. Canned bread

Menu

The menu for this evaluation included Tray-Pack entrees, vegetables, starches, and dessert items along with beverages and condiments. The 77th Armor also provided salads, an unusual item in a field menu. Canned bread, prepared according to the Military Specification 1070D⁶, was incorporated into this test. The bread was packaged in round cans with each can weighing 1 lb. 4 oz. and yielding 14 slices of bread. Table 1 shows the Tray-Pack items served.

Table 1. Fort Lewis Tray-Pack menu

Day	Noon	Meal	Evening
1	Salisbury Steak Peas Macaroni and Cheese Cherry Nut Cake		Roast Pork Green Beans Scalloped Potatoes Apple Dessert
2	Roast Beef Whole Kernel Corn German Potato Salad Peach Dessert		Lasagna Green Beans Cherry Nut Cake or Peach Dessert
3	Chicken Breasts Lima Beans Scalloped Potatoes Cherry Dessert		BBQ Beef Stewed Tomatoes Baked Beans Blueberry Dessert
4	Chicken Cacciatore Peas Stew Cut Potatoes Blueberry or Peach Dessert		

Disposables

In addition to the Tray-Pack foods, NLABS provided disposable compartmented trays and plastic knives, forks, and spoons. Using disposables with Tray Packs drastically reduces the labor and equipment required for sanitation. Cost and identification data for disposables are included in Table 2.

⁶Military Specification, MIL-B-1070D, Bread, White, Canned (1972).

Table 2. Cost and identification data for disposables used
at Fort Lewis

Item	NSN	Cost Each
Compartmented Paper Tray	7350-01-012-8787	\$0.04
Plastic Knife	7340-00-022-1316	0.03
Plastic Fork	7340-00-022-1315	0.01
Plastic Spoon	7340-00-022-1317	0.01

Manpower

Three cooks were made available for the four-day schedule. These cooks were provided with an overview of the MFSU components, the expected method of operation, and an explanation of the Tray-Pack concept. A second briefing and demonstration were conducted for the other cooks assigned to the dining hall, and a third demonstration, including the use of Tray Packs with insulated containers and a sampling of Tray-Pack products, was conducted for other interested personnel throughout the Division. Since the desired staffing level for MFSU operation is two, only two cooks were allowed to operate the MFSU at each meal. Any deficiencies indicating the need for additional manpower were noted by NLABS observers. The three cooks assigned to the MFSU rotated work during the evaluation so that one cook was off at each meal.

Acceptability of T Rations

Customer opinions on food acceptability were collected at the lunch meal on four days of the exercise and at the dinner meal for three days. One A ration breakfast was also included in the data collection as a basis of comparison with T rations. The food acceptance data were collected by interviewing customers at the feeding location as they finished their meal. Customers were first asked to rate the food on a nine-point scale with "1" reflecting "dislike extremely" and "9" indicating "like extremely". Then customers were asked to use a seven-point scale to rate entree temperature with "1" representing "much too cold" and "7" indicating "much too hot". Portion data were also collected for the entree items and the canned bread with "1" indicating "much too small" and "7" representing "much too large". The nine- and seven-point scales are presented on the following page.

Additional portion data were also collected to develop information on the yields of the Tray-Pack products under field conditions. These data were collected by counting the number of disposable compartmented trays and the number of Tray Packs used during each meal period. These counts indicated the number of meals served and the amount of food used. No attempt was made to control portion size during meals.

Customer Evaluation Scales

Nine-Point Scale Used to Rate Food Acceptability

- 1 Dislike Extremely
- 2 Dislike Very Much
- 3 Dislike Moderately
- 4 Dislike Slightly
- 5 Neither Dislike nor Like
- 6 Like Slightly
- 7 Like Moderately
- 8 Like Very Much
- 9 Like Extremely

Seven-Point Scales Used to Rate Entree Temperature and Portion Size

Temperature

- 1 Much Too Cold
- 2 Too Cold
- 3 Slightly Too Cold
- 4 Just Right
- 5 Slightly Too Hot
- 6 Too Hot
- 7 Much Too Hot

Portion Size

- 1 Much Too Small
- 2 Too Small
- 3 Slightly Too Small
- 4 Just Right
- 5 Slightly Too Big
- 6 Too Big
- 7 Much Too Big

III. RESULTS AND OBSERVATIONS

Customer Evaluations

The item and meal acceptability results obtained from customer evaluations of the T rations consumed during this exercise are summarized in Table 3. The final column, Overall Meal Mean, represents the customer rating of the meal combination and is not an average of the individual item ratings. Because this evaluation focuses on Tray-Pack products, overall means are calculated for each food category and appear at the bottom of Table 3.

Average scores for the entrees range from 5.0 to 7.0. All entrees received ratings of six or higher with the exception of Salisbury Steak. Vegetables were rated from 5.5 to 7.3 with all items in the category scoring above five (neither dislike nor like). The starches received the lowest overall ratings of the four with scores ranging from 5.0 to 7.3. The range of scores for desserts is the widest among the four categories with scores from 4.7 to 8.4. The lowest rated dessert item was Cherry Nut Cake with scores of 4.7 in two samples. By eliminating the Cherry Nut Cake scores, the dessert category is the highest of the four groups with scores ranging from 6.9 to 8.4.

As this is the third and final evaluation in the series, it is possible to compare specific items served at more than one location. Not all items were served at each location because the number of meals varied according to exercise duration. All Tray-Pack products with the exception of the NLABS-prepared Cherry Nut Cake were commercially formulated. Table 4 compares ratings for similar items served at different locations.

One notable difference in acceptance ratings involves Salisbury Steak, which was quite popular at Fort Bragg (8.4) but was not well received at Fort Lewis (5.0). Another product receiving mixed reviews was the NLABS-prepared Cherry Nut Cake. At Fort Bragg the product received a favorable rating of 7.4 while at Fort Lewis the ratings for this dessert averaged 4.7 over two meals. Since the product formulations were the same in each test, other factors caused the difference. The inclement weather conditions at Fort Bragg may have caused a hot evening meal to be more important to the customers than was the case at Fort Lewis where weather was more temperate and dry. The fact that ratings in general at Fort Bragg were higher than those at Fort Lewis lends some credence to this hypothesis. Alternatively, the difference with respect to the Salisbury Steak could be due to the time of day when the meal was served, midday at Fort Lewis and in the evening at Fort Bragg.

Positive ratings with average scores of five or higher were obtained at Fort Lewis in each of the four food categories and for the overall meal. The positive ratings obtained at Fort Lewis indicate the acceptability of the T ration for field use and confirm the results of earlier tests. Although the Fort Lewis results are considerably less positive than those at Fort Bragg, they do approach results at Fort Devens. A comparison of ratings for all three tests is included in Table 5.

Table 3. Detailed food acceptance data - Fort Lewis

Day	Tray-Pack			Tray-Pack			Tray-Pack			Tray-Pack			OVERALL					
	ENTREE		Mean	VEGETABLE		Mean	STARCH		Mean	DESSERT		Mean	BVG*		Mean	MEAL		
	Item			Item	Mean		Item	Mean		Item	Mean		Item	Mean		Item	Mean	Item
1	Salisbury Steak		5.0	Peas		5.5	Macaroni/Cheese		5.0	Cherry Nut Cake		4.7		7.8		7.4		5.7
	Roast Pork		6.4	Green Beans		6.5	Scalloped Potatoes		7.3	Apple		7.2		7.2		7.9		7.0
2	Roast Beef		6.5	Corn		7.3	Potato Salad		5.5	Peach		6.9		6.9		7.8		7.0
	Lasagna		6.8	Green Beans		6.9				Cherry Nut Cake		4.7		7.0		8.0		6.9
3	Chicken Breasts		7.0	Lima Beans		6.6	Scalloped Potatoes		5.1	Cherry		7.2		7.8		7.5		6.7
	BBQ Beef		6.0	Stewed Tomatoes		7.2	Baked Beans		6.4	Blue-Berry		7.1		7.5		7.8		6.6
4	Chicken Cacciatore		6.5	Peas		6.7	Stew Cut Potatoes		5.4	Blue-berry Peach		7.2		7.5		6.5		7.2
												8.4						

Numbers of Consumers/
item/meal

20-25 12-21 18-24 7-21 12-25 2-16 8-23 21-25

*BVG = Beverage

Table 4. Comparison of similar Tray-Pack items used in the test series

Meal Component	Fort Devens	Fort Bragg	Fort Lewis
<u>Entrees</u>			
Roast Beef	7.2	8.0	6.5
BBQ Beef	7.0	—*	6.0
Chicken Breast	7.8	—	7.0
Chicken Cacciatore	—	8.0	6.5
Roast Pork	—	8.2	6.4
Salisbury Steak	—	8.4	5.0
<u>Starches</u>			
Baked Beans	6.8	8.1	6.4
Scalloped Potatoes	7.0	7.3	6.1
German Potato Salad	—	7.6	5.5
Stew Cut Potatoes	6.9	7.5	5.4
<u>Vegetables</u>			
Green Beans	6.9	7.6	6.7
Lima Beans	6.8	7.5	6.6
Corn	6.3	8.2	7.3
Peas	—	7.9	6.1
<u>Desserts</u>			
Apple Dessert	7.3	8.8	7.2
Blueberry Dessert	6.4	8.0	7.2
Cherry Dessert	7.3	8.5	7.2
Peach Dessert	—	8.4	7.4
Cherry Nut Cake	—	7.4	4.7

* item not served

Table 5. Comparison of Tray-Pack acceptance data over the test series

	Fort Devens	Fort Bragg	Fort Lewis
Entrees	7.2	8.1	6.3
Vegetables	6.7	7.9	6.7
Starches	6.8	7.6	5.8
Desserts	7.0	8.2	6.7
Overall Meal	7.2	8.3	6.7
Entree Portions	3.2	—*	3.2
Entree Temperatures	3.6	—	3.7

* data not collected

The average ratings of entree temperatures at the Fort Lewis test range from 3.3 to 4.0 with an overall mean of 3.7, indicating temperatures slightly on the cold side of "just right" on the seven-point scale. This result was not unexpected given the January temperatures and the fact that the troops had no protection from the elements during meals. Although no control was placed on portion size, the cooks were advised to serve normal portions. The average customer response at Fort Lewis is 3.2 on the seven-point scale, indicating portions to be slightly too small.

As mentioned earlier, canned bread was used with T rations at Fort Lewis. The overall acceptability rating of canned bread is 5.9. This score, while favorable, is lower than those given commercial bread served at Fort Devens (6.6) and Fort Bragg (8.1). The portion-size rating for the canned bread was 3.8, slightly lower than "just right" on the seven-point scale. Although more data are required to make a conclusive statement about the acceptability of canned bread, the results obtained at Fort Lewis indicate that while canned bread is acceptable in the field, commercial bread is preferred.

MFSU Operation

As in previous evaluations, the MFSU performed its intended mission. Only two minor difficulties were encountered, neither of which resulted in a late or cancelled meal. First, the burner nozzle became clogged with fuel sediment and had to be replaced. Second, the generator, which supplied power to the burner and circulator, ceased operation while heating on the move. This difficulty was corrected by adding dry gas to the fuel tank and disconnecting the electrical ground strap. The ground strap was reattached later and the unit continued to run in a satisfactory manner.

MFSU Setup and Repack Times

According to the requirements of the LOA, the MFSU and assigned personnel must be able to begin serving meals within ten minutes after arrival at the serving location. The MFSU is also required to be repacked and ready to move to the next serving site within ten minutes. A comparison of setup and repack times for all three tests is included in Table 6.

Table 6. Comparison of MFSU setup and repack times over the test series

	<u>Fort Devens</u>		<u>Fort Bragg</u>		<u>Fort Lewis</u>	
	N*	Mean Time (min)	N	Mean Time (min)	N	Mean Time (min)
Setup	8	11:51	7	9:14	7	13:52
Repack	7	7:43	4	8:09	7	13:08

* Number of observations

At Fort Devens, the setup times ranged from 5 to 16 minutes with an average of almost 12 minutes. Repack times ranged from 5 to 12 minutes with an average of just under 8 minutes. Both the setup and repack times at Fort Devens approached the 10-minute requirement.

At Fort Bragg, the setup times ranged from 7 to 13 minutes with an average of just over 9 minutes. Repack times ranged from 5 to 10 minutes with an average of just over 8 minutes. The average setup and repack times at Fort Bragg were below the 10-minute target.

Unlike the results at Fort Devens and Fort Bragg, the Fort Lewis setup and repack times were both well over the 10-minute target. Setup times ranged from 8 to 19 minutes with an average of nearly 14 minutes. Fort Lewis repack times ranged from 9 to 17 minutes with an average of just over 13 minutes.

The longer times at Fort Lewis can be attributed to the presentation of additional menu items: specifically canned bread and salad. As mentioned earlier, canned bread was used exclusively at the Fort Lewis evaluation. Initially, the bread was opened and sliced upon arrival at the serving location. The slicing process coupled with opening the Tray Packs proved too time-consuming. After the first day, the bread was machine-sliced in the dining hall, wrapped in foil, and carried to the serving location. Differences in set-up and tear-down times on succeeding days are due to factors other than equipment, menu, or operations.

Costs and Portions of T Rations

The number of compartmented trays used was recorded to determine the number of customers fed at each meal and the number of Tray Packs used was recorded to determine the number of portions served per container. No attempt was made to control portions by ounces or any other measure. The portion data were recorded to determine the number of trays required to feed a given number of troops. It had been estimated that a Tray-Pack entree would serve 10 portions while vegetable, starch, and dessert Tray Packs would each serve 20 portions. Table 7 presents the average number of portions served per container from each food category for the three evaluations.

Table 7. Comparison of Tray-Pack portion data over the test series

	Fort Devens	Fort Bragg	Fort Lewis
Entrees	11	11	12
Vegetables	17	23	19
Starches	16	20	20
Desserts	14	17	20

Because no controls were placed on portion size, some variability exists among figures for the three evaluations. Given Table 7, the planning estimates of ten portions per Tray-Pack entree, and twenty portions per Tray-

Pack vegetables, starches, and desserts seem realistic until a standardized portion size for Tray-Pack items is agreed upon.

Another factor that affected these results is that only at Fort Devens was an MFSU used to feed small groups at several remote sites. Although most of the data were collected with the MFSU situated at one site for the meal period, the somewhat lower portions per tray obtained at Fort Devens can be attributed in part to the need to increase the portion sizes so as to use an even number of trays when feeding small groups. In serving 25 soldiers, for example, NLABS encouraged the foodservice officer to use three trays of entree rather than cut back on the amount of food provided so that only two trays would be used.

The Tray-Pack costs per serving are summarized in Table 8 for all three tests. These costs are presented not for their predictive value but simply as a matter of interest. Since they are based upon commercially available items and since portions were not controlled during these field tests, these costs may in fact represent upper limits on the cost of Tray-Pack usage in field exercises. As shown in Table 8, the meal cost at Fort Devens was higher than at Fort Bragg and Fort Lewis and probably reflects the effects of serving small groups at multiple sites. Although there is a linearly decreasing trend from \$2.49 to \$2.05 per meal from the first to the last test, no significance should be attached. The menu items were quite similar in all three tests, so no menu was necessarily more expensive than any other. The trend, if it is meaningful at all, may simply reflect a learning process on the part of NLABS' test managers that provided in turn more refined training at each successive test site.

Table 8. Comparison of Tray-Pack cost data over the test series

Item	<u>Fort Devens</u> Serving	<u>Fort Bragg</u> Serving	<u>Fort Lewis</u> Serving
Entree	\$ 1.36	\$ 1.11	\$ 1.05
Vegetable	.21	.37	.31
Starch	.33	.40	.33
Dessert	<u>.59</u>	<u>.48</u>	<u>.36</u>
Meal	\$ 2.49	\$ 2.36	\$ 2.05

Observations

The following observations are made relative to the series of three evaluations:

1. The paper labels separated from the Tray Packs during heating, resulting in clogged circulation hoses. To correct this, the labels were removed and the containers marked with indelible ink for identification.

2. A considerable amount of water had to be replaced due to spillage during transport of the MFSU. The addition of a gasket on the counter top would reduce water loss from spills.

3. Due to discoloration, the water in the converter was changed daily. Although the water, discolored by rust, is not inherently dangerous, the problem could be avoided by using stainless steel or copper heating coils.

4. The Tray Packs are too hot upon removal from the converter and cannot be comfortably transferred to the opener and serving table. A device to facilitate handling would increase safety and efficiency.

The cooks at all three evaluations suggested the following improvements:

1. The addition of a pass-through insulated container would allow Tray Packs to be opened in advance, leading to improved customer service flow.

2. Improve the Tray-Pack converter cover so that it will open in quarters.

3. Resupply of the serving line would be easier if the can opener were relocated closer to the converter.

Major David Mallory, High Technology Test Bed/Combat Service Support (HTTB/CSS), cited the need for a Tray-Pack container cover to help retain heat after opening and to avoid contamination when service is intermittent. He also expressed concern over the size of the MFSU, indicating that a smaller version would be preferred.

NLABS personnel responsible for monitoring the proceedings at the three evaluations made the following observations:

1. The beverage containers are not easily identified and cannot be efficiently operated with one hand by the customer while carrying a tray of food in the other hand.

2. Safety and efficiency could be improved with the addition of a ramp between the supply vehicle and the MFSU.

3. A levelling device should be added to the serving table to reduce spills from uneven terrain.

4. Control switches for activation/deactivation should be centrally located to improve efficiency.

IV. CONCLUSIONS AND RECOMMENDATIONS

Three major conclusions can be drawn from the results of this series of evaluations on the Mobile Food Service Unit and Tray-Pack concept. First, Tray Packs, as supplemented to provide a complete T ration, are acceptable to Army troops in the field. Second, the concept of heating, delivering, and serving the T ration from the MFSU has proven to be viable. Finally, the MFSU with T rations and disposable dinnerware can be efficiently operated by just two individuals.

In each of the three evaluations, the experimental prototype MFSU operated to expectations with no problems in the heating of Tray Packs on the move or in the reliability of MFSU components. Based on the results of these exercises, the following recommendations are made:

1. Tray-Pack foods have a place in military field feeding because of their demonstrated adaptability. The Tray Packs require only to be heated and opened to be served, they require no refrigeration, and have proven to be an acceptable field ration. Whenever practicable, Tray Packs should be incorporated into field exercises to facilitate the transition from the current system to the T ration/MFSU concept.

2. Further refinement of the prototype MFSU should be undertaken prior to its planned production. The following modifications are suggested:

- a. The Tray-Pack cover should be hinged to open in quarters;
- b. The holder should be improved to facilitate handling hot Tray Packs;
- c. A ramp should be made to connect the MFSU to the supply vehicle;
- d. All control switches should be centrally located;
- e. A lighting system should be added for after-dark operation;
- f. A tarpaulin should be added to provide protection from the elements;
- g. A pass-through insulated holding container should be added.

3. An improved version of canned bread could become a permanent component of the T ration, but suitable work space along with devices for opening and slicing the bread should be incorporated into the MFSU, if that is accomplished.

4. The Tray Packs should be stamped for identification since the commercially-used paper labels separate from the container and clog the heating equipment. A protective cover for use on opened Tray Packs should be developed to retain heat and to avoid food contamination during slow periods on the serving line.

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LIST OF ABBREVIATIONS

CSS: Combat Service Support
HTTB: High Technology Test Bed
LOA: Letter of Agreement
MFSU: Mobile Food Service Unit
MRE: Meal, Ready-to-Eat
NLABS: US Army Natick Research and Development Laboratories
SFKK: Supplemental Field Kitchen Kit
TFK: Tactical Field Kitchen
USATRADOCC: US Army Training and Doctrine Command